IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Janis Virbulis et al.

Group Art Unit: 1722

Examiner: Matthew J. Song

Serial No.: 10/053,446

Filed: January 17, 2002

For: PROCESS AND APPARATUS FOR PRODUCING A SILICON SINGLE CRYSTAL

Attorney Docket No.: WSAG 0128 PUS

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellant hereby petitions for a one-month extension of time to file a Brief in Support of the Notice of Appeal mailed December 11, 2006, thereby extending the time period within which to respond to March 12, 2007.

This is an Appeal Brief from the final rejection of claims 1, 2, 14, and 17 of the Office Action mailed on October 8, 2006 for the above-identified patent application.

I. REAL PARTY IN INTEREST

The real party in interest is Siltronic A.G., ("Assignee"), a corporation of Germany, by virtue of Assignment from the inventors to Wacker Siltronic Gesellschaft für Halbleitermaterialen, A.G., as set forth in the assignment recorded in the U.S. Patent and

Trademark Office on March 15, 2002 at Reel 012724/Frame 0148, and then to, by change of name, Siltronic A.G., recorded at Reel/Frame 015596/0720.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to the Appellant, the Appellant's legal representative, or the Assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1, 2, 14, and 17 are pending in this application. Claims 1, 2, 14, and 17 have been rejected and are the subject of this appeal.

IV. STATUS OF AMENDMENTS

A Response after Final Rejection of October 8, 2006 was not filed.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides a process for producing single crystal silicon. In one embodiment of the invention as set forth in independent claim 1, the process of the invention comprises pulling a silicon single crystal from a silicon melt which is contained in a crucible. (Specification, p. 2, ll. 17-20). The crucible is characterized in having a crucible wall and a diameter of at least 450 mm. (Specification, p. 3, ll. 5-12). A heat shield is placed above the crucible. (Specification, p. 3, ll. 5-12). Subsequently, the silicon single crystal is pulled with a diameter of at least 200 mm. (Specification, p. 5, ll. 11-16). The silicon melt is exposed to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically downward oriented force on the melt in a region of the crucible wall. (Specification, p. 3, ll. 1-4, p. 4, l. 19 - p. 5, l. 2). The magnetic field is applied with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt. (Specification, p. 11,

ll. 3-6). The magnetic field also a sufficient intensity to establish a convection which is initially directed to a bottom of the crucible (Specification, p. 5, ll. 16-18).

In another embodiment of the present invention as set forth in independent claim 14, the process of the invention comprises pulling a silicon single crystal from a silicon melt which is contained in a crucible. (Specification, p. 2, ll. 17-20). The crucible is characterized in having a crucible wall and a diameter of at least 450 mm. (Specification, p. 3, ll. 5-12). A heat shield is placed above the crucible. (Specification, p. 3, ll. 5-12). Subsequently, the silicon single crystal is pulled with a diameter of at least 200 mm. (Specification, p. 5, ll. 11-16). The silicon melt is exposed to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically downwardly oriented force on the melt in a region of the crucible wall. (Specification, p. 3, ll. 1-4, p. 4, l. 19 - p. 5, l. 2). The magnetic field is applied with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt. (Specification, p. 11, ll. 3-6). The magnetic field also a sufficient intensity to establish a convection which is initially directed to a bottom of the crucible (Specification, p. 5, ll. 16-18). The magnetic field is generated with three coils that are connected to a 3-phase power supply, with a phase angle in an order 0°-60°-120° or 0°-120°-240°. (Specification, p. 9, l. 19 - p.10, l. 4).

In still another embodiment of the present invention as set forth in independent claim 17, the process of the invention comprises pulling a silicon single crystal from a silicon melt which is contained in a crucible. (Specification, p. 2, ll. 17-20). The crucible is characterized in having a crucible wall and a diameter of at least 450 mm. (Specification, p. 3, ll. 5-12). A heat shield is placed above the crucible. (Specification, p. 3, ll. 5-12). Subsequently, the silicon single crystal is pulled with a diameter of at least 200 mm. (Specification, p. 5, ll. 11-16). The silicon melt is exposed to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically upwardly oriented force on the melt in a region of the crucible wall. (Specification, p. 3, ll. 1-4, p. 6, ll. 8-12). The

magnetic field is applied with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt. (Specification, p. 11, ll. 3-6).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 17 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al (U.S. Patent No. 6,077,343) in view of Haida (German Patent No. DE 3701733 A1).

Claims 1 and 2 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al (U.S. Patent No. 6,077,343) in view of Haida (German Patent No. DE 3701811 A1).

Claim 14 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al (U.S. Patent No. 6,077,343) in view of Haida (German Patent No. DE 3701811 A1), as applied to claim 1 above, and further in view of Lari et al (U.S. Patent No. 4,905,756) or Morishita et al (Japanese Patent No. JP 61-029128).

VII. ARGUMENT

A. Claim 17 is Patentable under 35 U.S.C. § 103(a) over U.S. Patent No. 6,077,343 in view of German Patent No. DE 3701733 A1

Appellants respectfully traverse this rejection under U.S. Patent No. 6,077,343 (referred to herein as "Iida et al") in view of German Patent No. DE 3701733 A1 (referred to herein as "Haida 1") for the reasons set forth below.

Each of the references cited by the Examiner, whether considered individually or in combination, is deficient in disclosing the present invention. The Examiner utilizes Iida et al to provide a method forming a silicon single crystal by the Czochralski method that allegedly uses a heat shield. Since Iida et al does not disclose the use of traveling magnetic

fields, Haida 1 is utilized to provide limitations regarding the magnetic field missing in Iida et al Haida 1 is itself deficient in that it fails to disclose a heat shield.

The Examiner incorrectly equates the "reflecting heat plate" mentioned in Iida et al to the heat shield of claim 17. Claim 17 requires a heat shield that is placed above the crucible. The "reflecting heat plate" of Iida et al is "attached to the lower portion of the cylinder." (Iida et al, col. 10, ll. 30-33). Although Iida et al does not clearly show where this position is, it is obvious that it is not above the crucible as required by claim 17 since it is at the bottom of some cylinder. Certainly, Iida et al does not enable one skilled in the art to practice the invention as disclosed in claim 17 in which a heat shield is used in a Czochralski process.

The Examiner concedes that "Iida et al does not teach using a traveling magnetic field" as required by each of independent claim 17. (Office Action dated October 8, 2006). It is therefore also apparent that Iida does not disclose "a traveling magnetic field which exerts a substantially vertically upward oriented force on the melt in a region of the crucible wall" as required by amended claim 17. Finally, Iida also fails to disclose the use of a magnetic field "with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt." The Examiner relies upon Haida 1 to provide the missing limitation of Iida regarding the use of a traveling magnetic field. However, Haida 1 fails to disclose "placing a heat shield above said crucible."

The Examiner states that "Haida et al [Haida 1] teaches an upward traveling magnetic field of 100 Gauss." This assertion is **not correct**. The Examiner relies upon an **incorrect translation**. Haida 1 states at col.5, line 41 as "abwärts wandernden". However, the correct translation of "abwärts" is "downward" which can be easily checked with a German-English dictionary or by comparison with the Haida 2 reference (col. 3, line 5). Therefore, the Examiner has rejected claim 17 under an incorrect presumption.

Haida 1 discloses a method for pulling silicon single crystals and subjecting the melt to a traveling magnetic field. A stated object of Haida 1 is "to minimize the dissolution of oxygen from silicon dioxide material of the crucible" (Haida 1, col. 3, ll. 33-35). Haida 1 accomplishes this objective by "applying the traveling magnetic field which serves for further suppression of the undesirable thermal convection flow 10, without reducing the forced convection flow 11 (Haida 1, col. 4, ll. 32-35). Example 1 of Haida 1 states that "the melt 4 was subjected to a **downward** traveling magnetic field of 100 Gauss in the close vicinity of the walls of the crucible 3." (Haida 1, col. 5, ll. 39-44). The results of this example:

> ...clearly reveal that subjecting the silicon melt to a traveling magnetic field was effective to reduce the concentration of oxygen to ¼ of that which was found in the absence of the traveling magnetic field, probably because a reduced dissolving of oxygen from the crucible forming silicon material as a **consequence of the suppression of the thermal convection** of the melt by the traveling magnetic field. . .
>
> (Haida, col. 5, l. 64-col. 6, l.5). (translations provided by Appellants)

Claim 17 does not disclose such a downwardly traveling magnetic field. Accordingly, claim 17 is allowable over the combination of Iida et al and Haida 2.

Claim 17 is also allowable because of the Examiner's inappropriate use of hindsight. The Examiner uses Iida et al to provide a method forming a silicon single crystal by the Czochralski method. The method of Iida et al allegedly uses a heat shield. Next, the Examiner uses the Haida 1 to provide the traveling magnetic field missing from Iida et al It is clear that the Examiner utilizes claim 17 as a roadmap for reconstructing the present invention from Iida and Haida 1. This inappropriate reconstruction it most evident from the strained equating of the "reflecting heat plate" of Iida et al with the heat shield of the present invention at set forth above.

Accordingly, for at least these reasons, claim 17 is patentable under 35 U.S.C. § 103(a) over the combination of Iida et al and Haida 1.

B. Claims 1 and 2 are Patentable under 35 U.S.C. § 103(a) over Iida et al in view of Haida et al (German Patent No. DE 3701811 A1)

Appellants respectfully traverse the rejections of claims 1 and 2 under 35 U.S.C. § 103(a) Iida et al and German Patent No. DE 3701811 A1 (referred to herein as "Haida 2") for the reasons set forth below.

The deficiencies of Iida et al are set forth above and apply to the present rejection with equal force. Specifically, these deficiencies include Iida et al's failure to disclose the use of traveling magnetic fields and/or a heat shield. Iida et al is also deficient in not including "a convection which is initially directed to a bottom of the crucible" as required by claim 1. Haida 2 is equally deficient with respect to each of these limitations. The Examiner does not allege that Haida 2 discloses the use of a heat shield.

The Examiner erroneously reads information into the teachings of Haida 2 that are not disclosed. Specifically, the Examiner states:

> The combination of Iida et al and Haida et al also teaches a traveling wave is placed in the pot to produce a downward driving power (ET pg 9, ln 1-2), **this clearly suggests applicant's applying a magnetic filed (sic) to establish a convection which is initially directed to a bottom of the crucible**.
>
> Office Action, October 8, 2006 (emphasis added)

The Examiner suggestion seems to sound in an inherency argument. The convection present in Haida 2 is not necessarily initially directed to the bottom of the crucible. As is clear from elementary heat transport theory, the initial direction of a convection depends on a number of

factors such as temperature gradients, densities, positioning of heat sources, physical size constraints, and the like. Therefore, the Examiner's assertion regarding the initial direction of the convection in Haida 2 is not supported.

Accordingly, for at least these reasons, claims 1 and 2 are patentable under 35 U.S.C. § 103(a) over Iida et al in view of Haida 2.

1. Claims 2 is Independently Patentable under 35 U.S.C. § 103(a) over Iida et al in view of Haida et al (German Patent No. DE 3701811 A1)

Claim 2 is independently patentable under 35 U.S.C. § 103(a) over Iida et al in view of Haida 2. Claim 2 requires that the silicon single crystal is pulled with an oxygen concentration of at least $5 * 10^{17}$ atoms per cm^3. Although the Examiner states that Iida et al discloses oxygen levels of 13-16 ppma, these values are not achieved in a process with an applied magnet field as in the present invention.

Accordingly, for at least these reasons, claim 2 is independently patentable under 35 U.S.C. § 103(a) over Iida et al in view of Haida 2.

C. Claim 14 Is Patentable Under 35 U.S.C. § 103(a) Over U.S. Patent No. 6,077,343 in view of German Patent No. DE 3701811 A1, and further in view of U.S. Patent No. 4,905,756 or Japanese Patent No. JP 61-029128

Claim 14 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al (U.S. Patent No. 6,077,343) in view of Haida (German Patent No. DE 3701811 A1), as applied to claim 1 above, and further in view of Lari et al (U.S. Patent No. 4,905,756) or Morishita et al (Japanese Patent No. JP 61-029128).

For the same reasons as set forth above, none of the references cited by the Examiner disclose the invention of amended claim 14. The deficiencies of Iida et al, Haida 1, and Haida 2 are set forth above. The Examiner relies on Lari et al and Morishita to provide the means of producing the traveling magnetic field. These later two references do not provide the missing limitations - "to establish a convection which is initially directed to a bottom of the crucible" or the use of a heat shield.

Accordingly, for at least these reasons, claim 14 is allowable under 35 U.S.C. § 103(a).

Appellants have previously paid the fee of $500.00 as applicable under the provisions of 37 C.F.R. § 41.20(b)(2) with the previously filed Appeal Brief. Appellants pay herewith the amount of $120.00 for a one-month extension. Please charge any additional fee or credit any overpayment in connection with this filing to our Deposit Account No. 02-3978.

Respectfully submitted,

Janis Virbulis et al

By: /s James W. Proscia s/
James W. Proscia
Registration No. 47,010
Attorney/Agent for Appellant

Date: March 12, 2007

BROOKS KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075-1238; Phone: 248-358-4400
Fax: 248-358-3351

Enclosure - Appendices

VIII. CLAIMS APPENDIX

1. A process far producing a silicon single crystal comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically downward oriented force on the melt in a region of the crucible wall and

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt and to establish a convection which is initially directed to a bottom of the crucible.

2. The process as claimed in claim 1,

wherein the silicon single crystal is pulled with an oxygen concentration of at least $5 * 10^{17}$ atoms per cm^3.

3-13. (Canceled)

14. A process for producing a silicon single crystal, comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm.

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically downward oriented force on the melt in a region of the crucible wall;

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt and to establish a convection which is initially directed to a bottom of the crucible; and

generating the magnetic field with three coils and connecting said three coils to a 3-phase power supply, with a phase angle in an order 0°-60°-120° or 0°-120°-240°.

15-16. (Canceled)

17. A process for producing a silicon single crystal, comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically upward oriented force on the melt in a region of the crucible wall, and

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt.

18. (Canceled)

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None